ON SOLIDITY IN ARCHITECTURE: Ornament, Shadow, and Construction

Laura Trazic
Ecole Polytechnique Fédérale de Lausanne

Abstract: This paper investigates the divergent and conflicting effect of both ornament and its shadow on traditional architectural solidity. Classical ornament is well-known to support the constructive idea of an edifice. Its main elements and patterns, from the column to the entablature, have throughout the centuries conveyed the idea of its constructive system. Treatises, beginning with Vitruvius' *De Architectura*, codified its proportions and disposition on key places of the façade in order to appraise, at first glance, the architectural solidity. Whatever may be the style—Doric, Ionic or Corinthian—whatever may be the purpose—church or palace—the mouldings and sculptures are deployed in an overall decorative system which should be in adequacy with the constructive idea.

Yet, as architects systematized sculptural ornaments, they could not but face an inherent difficulty induced by the relief itself: its own cast shadow. If sculptural ornament is supposed to reveal tectonics and solidity, its shadow may have the power to affect the latter. How is it that a mere shadow, ever-changing and moving on the façade, could endanger the solidity of a building and the mass and weight of the stones?

Based on architecture treatises, this paper will focus on a critical gap between two stances. First, we shall observe how Vitruvius and Alberti linked solidity with ornaments and their shadows, and if it was even of importance for them. A second step shall bring us a few centuries later in the French eighteenth century, when architecture borrowed from painting theories the question of aesthetic shadow. Beforehand, definitions of the three terms used—solidity, ornament, and shadow—may be useful to capture how shadows put at risk architectural solidity.

Keywords: Shadow, ornament, decorative system, solidity

INTRODUCTION

Vitruvius and Alberti agreed on the fact that the three principles of architecture—beauty, utility, and solidity, are fundamentally intertwined. Whether it comes to the Vitruvian *firmitas-utilitas-venustas* or the Albertian *soliditas-comoditas-voluptas*, "these qualities are so closely related that if one is found wanting in anything, the rest will not meet with approval" (Alberti 1988, VII-1, 189). Although *solidity* and *beauty* seem diametrically opposed from each side of the triad, they are intrinsically intertwined. From the fulfillment of their own conditions depends their respective and mutual achievement and the praise the edifice might eventually receive. In order to meet the requirements for these two principles, architects have at their disposal a range of traditionally theorized conventions. In fact, the strong link between construction and beauty is deeply rooted in the discourse on orders and ornaments, since a well-designed ornamentation—through the proportion and disposition of its elements—is seen as the key to convey at once the beauty and the constructive idea. The harmony of the composition depends mainly on a balanced ratio between voids and solids.

Yet, as ornaments are ruled by a system of proportions that define their heights, widths, and depths, they naturally cast shadows over the façade's main plan. The question raised at this point could be the following: *do the shadows cast by ornaments interfere with the solidity that they are simultaneously supposed to achieve, and how could this happen?*

The research will be conducted through theoretical writings so as to reveal if shadow has ever been of concern and if its hypothetical link with solidity has been addressed or, at least, noticed in traditional architectural theory. The first place to find the premise of an answer is in the Vitruvian and Albertian treatises. The second historical period the study investigates will be the French Enlightenment. As a matter of fact, architects of the eighteenth century faced a crisis in their practice, since the rise of structural engineering forced them to reconsider their discipline and to reinterpret architecture foundational principles. Solidity was then a major issue to address, and the topic of shadow in architecture increased exponentially in parallel during that period.

A second part will investigate how Vitruvius and Alberti did conceive the link between solidity, ornament, and shadow, if at all, and a third part will explore the views of the French Enlightenment's architects. Beforehand, we will briefly present the three studied protagonists that compose the object of this study, namely the principle "solidity", the object "ornament", and the phenomenon "shadow".

1. SOLIDITY, ORNAMENT, AND SHADOW

1.1. SOLIDITY IN ARCHITECTURE: TO *BE* AND TO *SEEM*

The notion of solidity links, as the two sides of a same coin, two physical aspects of the building. To ensure a lasting stability to the latter, the notion gathers both a technical and an aesthetical aspect: the efficiency and assemblage of employed materials and also their dimensions and positions. The second aspect relies on the application of the rules of proportion established since Vitruvius, and on a very long tradition of construction experience. These two aspects evolve jointly and depend as much on the construction's scientific objectivity as on the subjectivity of human perception. Solidity must then follow two imperatives: not solely that the architectural object has to *be* solid, but also that it has to *seem* like it is.

Solidity therefore implies a proportional system that codifies the geometry of constructive elements themselves according to their materiality—height, breadth, depth—and the geometry of each element with respect to the others, including the voids that separate them, as do the different styles of intercolumniation. Homothecy is the main mathematical operation that maintains the system whose module is usually "taken from the diameter at the base of the column" (Alberti 1988, VII-7, 202). If the architect chooses to step out of the conventional proportional system, the conceived edifice is exposed to the possibility of looking less solid and less beautiful.

1.2. PROPORTIONS OF THE ORDERS: HEIGHT, WIDTH AND *DEPTH* OF ORNAMENTS

The realm of appearance reigns over structural qualities as over any decorative system. Actually, trying to distinguish them would be unsuccessful and for Alberti, such a distinction simply did not exist. Ornaments compose orders, which participate in proportioning and articulating the masses. Columns, entablatures, or even to a lesser extent, every bracket, baluster, volute, and sculpture aim to tell the narrative of construction through their disposition according to key tectonic parts of the façade. Among these listed ornaments, columns, entablature, and moldings are governed by well-defined proportion rules whereas the other elements offer a greater freedom (*licentia*) with regard to their forms and dimensions (Payne 1999, 1). Each order may be recognized through specific ratios applied to their height, breadth, and depth. This latter is given according to a reference surface, usually the wall, and applies to all protruding or recessing ornaments. These reliefs may either keep a physical contact with the wall, such as high or bas-reliefs, or they may be completely detached, such as round sculptural figures or free columns. Depth completes the proportional definition of orders, even though it cannot be understood as a strict differentiating feature since, regardless of the order, overall projections are limited to 45°, which means that their maximal depth must not exceed their height as Alberti states, ""Cornice" we call the top section, protruding above the rafters. The general rule given for all projections also applies here, in that the distances that any section projects from the wall must also equal its height." (Alberti 1988, VII-9, 210)

So far, we have seen that, first, solidity traditionally depends on the proportions of orders, and, second, that these orders present a relief which depth is also theorized. As the façades are to be exposed to sunlight, whose rays' strength depends on climatic conditions, their ornaments naturally cast shadows on themselves according to their orientation.

1.3. THE SHADOW, PHENOMENON, OR OBJECT?

The French word *ombre* eludes the distinction that can be found in English between shade and shadow, a distinction that does not refer to its nature (shades and shadows are both the product of a physical phenomenon and their very existence relies on light and on an obstacle that blocks its rays), but renders better its double perception: shade is atmospheric and quantitatively undefined, while shadow may be perceived as a countable object, even though abstract. The shadow's reification must not distract from its necessities: even though it ever-moves uncontrollably over surfaces it does not belong to, shadow is always attached to an object (Arnheim 1974, 315). This is the specific case of the *cast shadow*, unlike the *core shadow* that sticks to the object's body.

How could such a phenomenon affect the solidity; how could it put at risk the mass and weight of a construction made of stones, bricks, wood or metal? In 1990, when Arden Reed wrote, "It might seem that to talk about architecture and shadows automatically means to talk about solidity and vacuity, or presence and absence" (15), his intuition lent to shadow some power over architectural solidity. The structural fiction built according to specific proportions could be disturbed by their modification. Since solidity relies on a proportional system, shadows might interfere by a modification of the beholder's perception of voids and solids: a darkened surface may instead appear as a void. Eventually, it seems that shadows have the power to hack the reading of solidity. Paradoxically, it is the set of ornaments arranged to support the narrative that invites the hackers in. The two following parts will highlight how the phenomenon has been acknowledged by Vitruvius, Alberti, and French architects of the eighteenth century, and discuss the ornaments that have been specifically pointed out.

2. THE FIRST APPREHENSIONS: ORNAMENTS' SHADOWS FOR VITRUVIUS AND ALBERTI

2.1 THE FUNCTION OF SHADOW IN THE VITRUVIAN AND ALBERTIAN DISCOURSES

The matter of shadow and darkness represents different concerns for the theoreticians. For Vitruvius, shadows are mainly related to the gnomonic (*gnomonica*), one of the three components of architecture, along with the edification (*aedificaoria*) and the construction of machines (*machinatio*) (Cache 2019, 16-32). In his *De re aedificatoria*, Alberti's shade is either a matter of climatic ambiance of an area delimitated by walls[1], or it is given a hint of sublime aesthetics with the exaltation of religious feeling through the darkness of a temple.[2] Alberti wrote treatises on both architecture and painting. It is only in his *De pictura* that he had to confront the problem of shadows. The author built connections between these two arts on the terrain of beauty and ornaments. He directly announced to the readers of the *De re aedificatoria*, at the beginning of the seventh book on ornaments of sacred edifices, "Our inquiry will prove so valuable that not even painters, who are the most exacting seekers of delight, would be without it; it will also prove so delightful that—to put it simply—you will not regret having read it." (Alberti 1988, VII-1, 189)

In the opposite manner, the wording in the *De Pictura* differs, "Only from the painter himself, if I make no mistake, the architect took in fact the architraves, the capitals, the bases, the columns, the pediments, and all other similar ornaments of the edifices" (Alberti 2011, II-26, 45-6).

2.2. ALBERTIAN SOLIDITY AND THE *SCOTIA*

Shadow is not a threat for the Albertian solidity. The constructive fears expressed by the architect are much more directed towards overhanging members, which he exhorts the reader to avoid.[3] However, one specific molding, part of the column base, drove Alberti to make a comment: "The scotia is a circular recess, like that in the wheel of a pully, sandwiched between the tori." (1988, VII-7, 202) Such a recess at the base of the column is enough to worry Alberti, who immediately cleared the issue by determining its depth:

> The scotia consists of a hollow channel and two thin fillets running around the edges of the channel. Each fillet takes up a seventh of the thickness; the remainder is hollowed out.
>
> It is essential in all building, as we said, to take care that everything rests on a solid base. Nor will it be solid, if a plumb line dropped from any masonry above meets air or void. When carving out the channel of the scotia, they were always careful not to cut beyond the vertical of whatever was built on top. The tori projected five eights of their thickness; and the thicker torus at its widest point was aligned with the profile of the die within the base. So much for the Doric.
>
> The Ionians found the thickness of the Doric base to their liking, but doubled the number of scotias, and added two thin rings in the middle, between the scotias. (1988, VII-7, 203)

In his annotated translation of Vitruvius republished in 1684, Claude Perrault clarified, "The Greek word *Scotos* means darkness. The recessed part of the base is called Scotia, because it is the most shaded." (Perrault 1684, 90)[4] It is mainly the word scotia that prevailed in architectural French literature, and its etymology was invariably recalled to underline its shadow-making function.

Scotia combines in one ornament both the visual experience of shadow and the perception of its void. Not only did shadow give its name to a significant molding, but it also became an architectural substance.

2.3. VITRUVIUS AND THE DIMINISHING EFFECT OF LIGHT

The case of the scotia is that of a core shadow, cast by a volume on its own body and which, when too dark, put at risk the constructive idea of stacked masses, such as a shaft over its base. The cast shadow was also noticed for the very same effect later on by Perrault in his translation of Vitruvius, regarding the Aerostyle intercolumniation.

In the original text, Vitruvius expressed his concern regarding the visual effect of a strong light on columns' form readability in general and their thickness in particular:

> For the thickness of the shafts must be enlarged in proportion to the increase of the distance between the columns. In the Aerostyle, for instance, if only a ninth or tenth part is given to the thickness, the column will look thin and mean, because the width of the intercolumniations is such that the air seems to eat away and diminish the thickness of such shafts. . . . We must therefore follow the rules of symmetry required by each kind of building. Then, too, the columns at the corners should be made thicker than the others by a fiftieth of their own diameter, because they are sharply outlined by the unobstructed air round them, and seem to the beholder slenderer than they are. Hence, we must counteract the ocular deception by an adjustment of proportions. (Vitruvius 1960, III-3, 84)

In his translation, Perrault considered instead the role of shadow in this visual deception. He documented his disagreement with a drawing entitled *How light and shadows may make appear columns thicker or slenderer depending on whether they are more or less spaced; the columns A and B seeming slenderer than the columns D and C, even though they are equally thick* (82). The drawing represents two different intercolumniations over a gradient shaded background. Graphically, the drawing is more intuitive than geometric, and the shadows are not calculated (figure 1).

Perrault translated *air* by *l'air & le grand jour*, and then completed and corrected the daylight-idea given by Vitruvius. He commented:

> If air here means light, as there is a great similitude, it seems that columns brought closer to each other, shall provoke an opposite effect to what is said here, that is to say that the closer they are, the slenderer they shall appear, because a column whose neighbors subtract the daylight that would otherwise illuminate its sides if they were further apart; is obscured on the right and left with two shadows that merge with the one behind and which reigns along the portico, which diminishes its apparent thickness, that would seem differently if its sides being illuminated were cutting more sharply the shade behind; as it is seen in Figure 1 of the table XVII where columns A B that are squeezed up seem more slender than columns CD, even though they all have the same thickness. We may then say that the true reason for this seemingly column-thickness diminution when they are distant from each other, is that they do not appear adequate to carry a long entablature; and also, that the necessity to thicken the columns as one may move them apart, is based on the fact that a heavy load requires something stronger to support it. (81)[5]

While Vitruvius thought that columns might be eaten away by the light, Perrault, on the contrary, accused the cast shadow: a similar mechanism could affect the columns' perceived solidity, and therefore would alarm the beholder on their weak capacity to bear the entablature's load. Shadow operates as a proportion-modifier and creates the illusion of a "lightness that destroys the harmony", as Le Camus de Mézières stated, since the column seems as slender as "a reed, incapable of supporting any weight; and this violates one of the most essential principles of all, namely the idea of solidity that every structure must have." (Le Camus de Mézières 1972, 85)

In expressing a differing opinion from that of Vitruvius, Perrault brought forth the viewpoint of his time, regarding the nature of ocular deception, and its being created more by shadows than by light. Shadow became a more powerful danger for proportion, especially during this century when the conditions of solidity were evolving.

3. SHADOWS IN THE DECORATIVE SYSTEM OF FRENCH ENLIGHTENMENT'S ARCHITECTS: LE CAMUS DE MEZIERES, BOULLEE AND LEDOUX

3.1 EVOLUTION OF THE CONDITIONS OF SOLIDITY: BETWEEN CALCULATION AND SENSATION

The solidity of the architectural form was, during the French Enlightenment, battling between two positions that emerged from an increasing differentiation between architect's and engineer's practice. On one side stood Blondel and the verisimilitude of construction, on the other "revolutionary architects", (Kaufmann 1952) such as Boullée and Ledoux, who explored the notion of solidity through new architectural effects rendered with simple geometrical shapes. Calculation or sensation became the two main ways to achieve it.[6] From Condillac's legacy for who sensation is at the origin of knowledge, to the lectures by Monge, Lagrange, and Laplace at *les Ecoles Normales*, where mathematical rationality triumphs, the rapports are not as dichotomous as they may seem, and one may simply not oppose calculation to sensation.

The engineer Riche de Prony, in his "Reflections on the organization of an academy that would aim at the perfecting and the teaching of construction" [*Réflexions sur l'organisation d'une académie qui aurait pour objet la perfection et l'enseignement de la construction*] stated that "the art of discussing and analyzing is not incompatible with the one of painting and stirring" (Quoted in Picon, 95)[7] and suggested to add the study of Greek proportions, alongside the teaching of mechanics.

3.2 THE RISING APPRECIATION OF SHADOWS: BETWEEN GEOMETRY AND INTUITION

The question of shadows followed the very same dynamics, between sensation and calculation. On one hand, the shadow of architectural form was considered from a mathematical point of view. Shadow arose in architecture through descriptive geometry for which Dupain de Montesson, tactician, surveyor and engineer initiated in 1750 the tradition with the first edition of *The Science of Shadows* [*La Science des Ombres, par rapport au dessein. Ouvrage nécessaire à ceux qui veulent dessiner l'architecture civile & militaire, ou qui se destinent à la peinture*] the first french manual dedicated to the geometrical representation of shadows in architecture, a tradition pursued subsequently by Delagardette and L'Eveillé.[8]

The drawing convention of shadow places the light source with an angle of 45° on both horizontal and vertical plans. The final table of *La Science des ombres* is dedicated to "the effect of light on mixed bodies" (Dupain de Montesson 1786, 80).[9] and examines the particular case of ornaments such as the base and its scotia, the column capital, the torso, and different moldings of the entablature (figure 2). To calculate shadow according to a theoretical sun position allows one to simulate a phenomenon that is in its nature ever-changing but predictable at a certain time. The theoretical moment chosen enables, by a geometrical report of points, to read the depth of the relief thanks to the length of its cast shadow. This latter then introduces in the orthographic drawing the third dimension.

On the other hand, and in a similar effort as the one made by the beholder who reads a shaded drawing

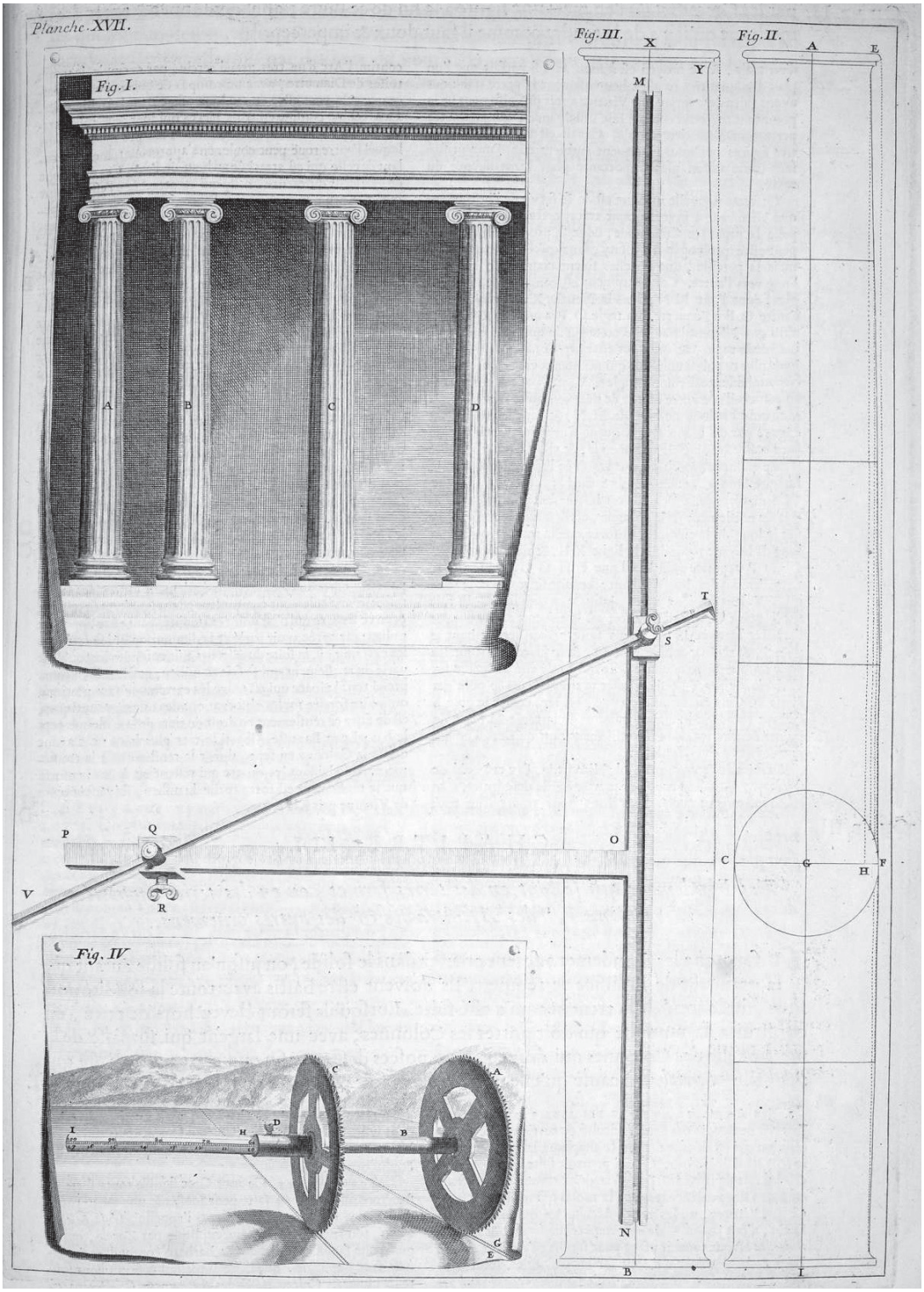

Figure 1: Demonstration of different effects of shadows on the perception of the thickness of columns. (Claude Perrault, Les dix livres d'architecture de Vitruve, table XVII, 1684)

to understand the relief, for sensualists like Condillac, the shadow represents the means by which one may recognize at first glance "figures, sizes, situations and distances" (Condillac 1792, 4)[10], even though this knowledge requires the sense of touch at a preliminary stage of perception.

3.3 TOWARDS A DECORATION BY SHADOWS: PICTORIAL ORIGINS AND ARCHITECTURAL LIMITS

Whether it be related to a geometric approach or to a sensualist one, this type of shadow seems to result from the transition of a pictorial knowledge to an architectural knowledge. Undeniably, shadow is one of the painter's favored tools. It is at the very origin of the discipline: Dibutade's daughter invented painting while tracing the contours of her beloved's cast shadow on a wall;[11] Da Vinci resolved the problem of perspective by analogy with the geometry of shadow.[12] Not only does shadow enhance the verisimilitude of a scene by giving the sensation of relief, but it also is a powerful tool for pictorial composition. From the Renaissance with Alberti, and more particularly from the second half of the seventeenth century in France, the challenge of treatises on painting was to measure and dose the quantity of light according to the quantity of dark on the canvas and their respective position. The term *chiaroscuro* ["clair-obscur"] entered at that time French painting theory, as well as, *group*, *masse of light and dark*, and *rest*, each of them abiding by the principle of *harmony*.

It is with an homage to Watelet that Le Camus de Mézières opened *Le Génie de l'Architecture*. Watelet was a painter and the most influential theoretician of his time although he did not make any major contribution to his discipline besides transmitting ideas developed during the previous century by Dufresnoy and his friend and translator De Piles.[13] In Le Camus' work, which aimed at an audience of architects, the author proposed to build an "analogy of the proportions of Architecture with our sensations" (Le Camus de Mézières 1972, 1). These sensations are seen as the result of the effects of architecture on the soul. It is in the collective effort of the three sisters,[14] architecture, sculpture and painting that Le Camus recognized the potential for achievement of the greatest effects. The making of effects lay in the combination of basic elements such as "the whole, the masses, the proportions, the shadows, and the lights" (75). Shadows of protuberance, in which one may find ornaments, became the privileged place for an intersection between architecture, sculpture and painting. The artistic crossing of these lies in the common implementation of means, know-how and aesthetical intentions: architecture, in the sense that shadow is appointed as a tool dedicated to creating effects; sculpture, in the sense that it is the protuberant ornament that casts its shadow on the façade; and finally painting, in the sense that its methods are borrowed by the architect to compose their façades.

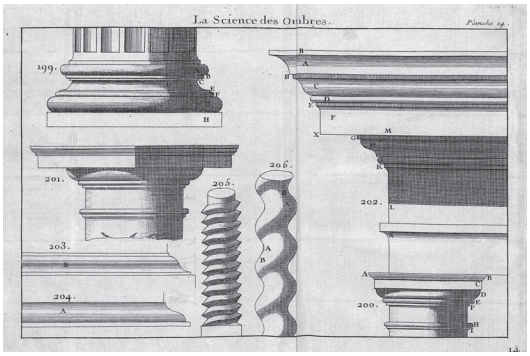

Figure 2: The effect of light on mixed bodies. (Dupain de Montesson, L.-C. La science des ombres… Nuremberg: Weigel, 1786)

In Le Camus de Mézières' words, shadow became a central topic in architectural composition. The author also considered himself as a forerunner in his will to integrate shadow into architectural theory.

> "It is impossible to pay too much attention to the masses in a building, to their intended effect in elevation, and to the greater or lesser degree of light that may result; the shadows must temper the light, and the light must temper the shadows. In this principle, success resides; here alone true beauty is to be found; this can be considered and discussed, the truth will come to light, and the greatest benefits will ensue. This observation, we repeat, is essential. Even the most intelligent Architect can hope to succeed only by adapting his design to the exposure of the Sun to the principal parts of his building. Like the skillful Painter, he must learn to take advantage of light and shade, to control his tints, his shadings, his nuances, and to impart a true harmony to the whole. The general tone must be proper and fitting; he must have foreseen the effects and be as careful in considering all the parts as if he had to show a picture of them." (95)

The injunction is double and seems at the edge of contradiction. The architect has to borrow from the painter his compositional tools regarding the disposition of light and shade on his façade-canvas. Yet, in contrast to the painter for whom light is chosen and unique, the architect ought to think his work stretching out in time and space and be prepared to see the well-thought shadows evolving, being distorted and running along the façade. While conceiving an architectural approach based upon the one used by painters, Le Camus overlapped on the façade two layers that could become antithetical. Indeed, it is difficult to handle at once the changing effects of shadows cast by strong reliefs and the necessity of expressing constant solidity.

The respect of proportions is no longer the only requirement that ornaments have to fulfill, because "it is light and shade that determine its success and

contribute most to its character." (100) The effect of smooth or sharp shadows should be the consequence of a certain disposition and depth given to ornaments.

> "The true artist […] will understand that if he wishes his building to set a calm and gentle scene, he must combine masses that do not differ too widely; he will see that they must have too much variety and relief and that the prevailing tone must be one of tranquility and majesty; the contrasts of light and shade must be well regulated, for any excess of either would be harmful. Nothing better conveys the character of mildness than shadows that become less dense as they grow longer." (94)

Even though the definition of shadows only relies on the projection of ornaments and masses and not on their forms, edges or surfaces, Le Camus's decorative recommendations lean on a utilitarian construction that one may appraise from the table of contents: characters and architectural effects are at the center of his theory and grounded on a fine programmatic dissection, since "each room must have its own particular character." (88)

Le Camus was attached to the very notion of solidity, as we have seen earlier. Yet, he never proposed any technical means to solve the problem that shadows might present. He was instead much more concerned with the classification of its effects and with the promotion of pictorial tools in architecture.

Boullée and Ledoux abandoned the traditional models supported by Blondel and conceived buildings made of simple and pure geometrical shapes, with ornament freed from classical rules and a sensualist accent very similar to Le Camus' discourse. Projections and their shadows are recognized as basic elements to the architectural forms. "What might one say of a monster that would have neither arms nor legs? Such would be the fate of Architecture were one to remove the only effects obtained through its main parts; well-combined projections, cast shadows […]" (Ledoux 1804, 28).[15] The architects pursued the painter's example and Ledoux questioned: "You who wish to become an Architect, begin by being a painter: what variety will you find spread over the inactive surface of a wall, whose picturesque eloquence does not stir the apathetic multitude" (112).[16] The façade again is conceived as a canvas on which the architect would dispose his shadows. Yet, Ledoux was very well aware of the variability of these effects and reminded of the inconstancy of the shadows cast by projections "under a moving star" (47).[17] The description Ledoux made of the director's house of the Arc-et-Senans Royal Saltworks is an occasion to assess a strong decorative will through the use of shadows, including those cast by the banded rustication of columns and pilasters whose recess between "squared and rounded courses […] produce sharp shadows, and vivid effects " (134).[18] The need for strong effects made by such shadows is justified by the distance of the beholder from the edifice, distance that blurs the details of its ornaments.[19] Merging shadow into the decorative system cannot however be done at the expense of the "apparent solidity" that Ledoux opposed to an "actual solidity" (45).[20] Ornaments that present significant projections, like the cornice, or overhanging roof, produce shadows that may subtract "the seeming solidity that one desires" (119).[21]

CONCLUSION

Despite the fact that Vitruvius developed a discourse on shadow in his *gnomonic*, and that Alberti wrote both treatises on architecture and painting, the theorists never openly constructed a link between shadow, ornament and the appearance of solidity. In France, it is only during the eighteenth century that architecture began to consider the play of shadow on façades. It is also during this century when architecture had to face a radical change in its practice: with the emergence of engineering and therefore the questioning of the architect's role, this latter had been sought in its relation to other visual arts. The result is that the very pictorial approach of decoration had to overlap the pictorial approach of solidity, creating thus vivid conflicts. This century may be seen as launching the subject matter, since the link between shadows, decoration and solidity found an unexpected development during the following century through the figures of Quatremère de Quincy, Viollet-le-Duc, or John Ruskin in England. These architects and critics not only underlined the problem of shadows on solidity, but they also formulated pragmatic methods to limit its impact and enhance its decorative qualities. The nineteenth century, triggered by the romanticism of shadow, is the century when architecture fully captured the theoretical question of its function in the decorative system and mastered it. Column, scotia and cornice became part of a wider range of ornamental shapes which, according to their edges, geometry and reflective properties, were conceived as devices and means to design decoration by shadows.

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ENDNOTES

1 "Account should be taken of the seasons, so that rooms intended for summer use should not be the same as those intended for use in winter, in that they should have different sizes and locations; summer rooms should be more open, nor is it amiss if winter ones are more closed in; summer ones require shade and draught, while winter ones need sunlight." (Alberti 1988, I-9, 23); "…the infill and the twin skins or shells on either side, one to keep the wind and sun out, the other to protect the area within." (III-6, 69)

2 "The window openings of a temple should have modest dimensions and should be placed high up, where they have a view of nothing but the sky, which will not divert the minds of celebrant or supplicant from divine matters. The awe that is naturally generated by darkness encourages a sense of veneration in the mind; and there is always some austerity about majesty. What is more, the flame, which should burn in a temple, and which is the most divine ornament of religious worship, looks faint in too much light." (VII-12, 223)

3 This warning relates to the preference for square columns under arcades instead of round ones, a structural argument unexpectedly placed in the part dedicated to ornaments, "For arched colonnades quadrangular columns are required, the work would be defective with round columns, since the springing of the arches could not be fully supported by the solid of the column, and whatever lay in plan beyond the circle contained by the square would rest on nothing but thin air." (VII-15, 236); a similar warning may be found in the third book, "Give your wall the firmest possible base; the top must be centered along the vertical and must correspond exactly to the bottom" (III-11, 78)

4 "Le mot Grec *Scotos* signifie obscurité. La partie qui est enfoncée dans la base est appelée Scotie, parce qu'elle est la plus ombragée". Claude Perrault, *Les Dix Livres d'Architecture de Vitruve* (Paris: Jean Baptiste Coignard, 1684), 90. Translation by the author.

5 "Si l'air signifie icy la lumiere, comme il y a une grande apparence, il semble que les Colonnes serrées les unes contre les autres doivent faire un effet contraire à ce qui est dit icy, c'est-à-dire que plus elles sont pressées, plus elles doivent paroistre menuës, parce qu'une Colonne à qui ses voisines dérobent le jour qui illumineroit ses costez, si elles estoient plus éloignées, est obscurcie à droit & à gauche de deux ombrages qui se confondent avec celuy qui est derriere & qui regne le long du Portique, ce qui diminuë l'apparence de sa grosseur, qui paroistroit tout autrement, si ses costez estant illuminez coupoient plus distinctement cette ombre qui est derriere ; comme il se voit dans la I. Figure de la Planche XVII. où les Colonnes A B, qui sont serrées l'une contre l'autre paroissent plus menuës que les Colonnes CD, quoy qu'elles soient toutes d'une mesme grosseur. *On peut donc dire que la veritable raison de cette apparence de la diminution de la grosseur des Colonnes quand elles sont éloignées, est qu'il semble qu'elles ne sont pas suffisantes pour porter un long entablement ; & qu'aussi le necessité de grossir les Colonnes à mesure qu'on les éloigne l'une de l'autre, est fondée sur ce que la plus grande charge qui est soutenuë, demande quelque chose de plus fort qui la soustienne*." Perrault, *Les Dix Livres d'Architecture de Vitruve, 81*. Translation and emphasis by the author.

6 Antoine Picon, "Solidité et construction, quelques aspects de la pensée constructive des Lumières", *L'Idée Constructive en Architecture: Actes du Colloque Tenu* à Grenoble au 28 au 30 Novembre 1984, ed. Xavier Malverti (Paris: Picard, 1987), 95.

7 "l'art de discuter et d'analyser n'est point incompatible avec celui de peindre et d'émouvoir". Gaspard Riche de Prony, *Réflexions sur l'Organisation d'une Académie qui aurait pour Objet la Perfection et l'Enseignement de la Construction*, Manuscrit E.N.P.C, MS1056. Quoted in Picon, "Solidité et construction, quelques aspects de la pensée constructive des Lumières", 95. Translation by the author.

8 Claude-Mathieu Delagardette, *Leçons Elémentaires des Ombres dans l'Architecture, faisant suite aux Règles des Cinq Ordres de Vignole*... (Paris: Dallenne, 1851); Charles Stanislas L'Eveillé, *Etudes d'ombres à l'usage des écoles d'architecture*, (Paris: Treuttel et Wurtz, 1812).

9 "l'effet du jour sur les corps mixtes". Dupain de Montesson, *La Science des Ombres*, 80.

10 "des figures, des grandeurs, des situations et des distances". Etienne Bonnot de Condillac, *Le Traité des Sensations* (Parme, 1792), 4.

11 Pline the Elder, *Naturalis Historia*, XXXV-15 and 43

12 Thomas Da Costa Kaufmann, "The perspective of shadows: the history of the theory of shadow projection", *Journal of the Warburg and Courtauld Institutes* 38 (1975), 258-87, https://www.jstor.org/stable/750956.

13 Charles-Alphonse Dufresnoy, *De Arte Graphica* (Paris: L'Anglois, 1668) ; Roger De Piles, *Cours de Peinture* (Paris: Etienne, 1708).

14 The eighteenth French century was keen on calling arts "sisters" as if they were ancient muses.

15 "Que diroit-on d'un monstre qui n'auroit ni bras ni jambes? C'est ce que deviendroit l'Architecture dont on supprime les seuls effets que l'on puisse tirer des corps; des saillies bien combinées, des ombres portées […]". Claude-Nicolas Ledoux, *L'Architecture considérée sous le Rapport de l'Art, des Mœurs et de le Législation* (Paris: Ledoux, 1804), 28. Translation by the author.

16 "Vous qui voulez devenir Architecte, commencez par être peintre : que de variétés vous trouverez répandues sur la surface inactive d'un mur, dont la pittoresque éloquence ne remue pas la multitude apathique". Ledoux, *L'Architecture*, 112. Translation by the author.

17 "toujours assujetties aux emprunts forcés d'un astre mobile". Ledoux, *L'Architecture*, 47. Translation by the author.

18 "les assises carrées et rondes […] reculent et produisent des ombres tranchantes, des effets piquants; ces combinaisons de l'art changent les contrastes à mesure que le soleil s'étend dans sa course méthodique". Ledoux, *L'Architecture*, 134. Translation by the author.

19 "Projections cast sharp shadows; it is a mean to substitute strength to the weakness produced by distance […] This is the power of forms that reign over distances." ["Les saillies produisent des ombres piquantes; c'est un moyen de substituer des forces à la foiblesse produite par l'éloignement. […] Tel est le pouvoir des formes qui commandent aux distances"]. Ledoux, *L'Architecture*, 135. Translation by the author.

20 "solidité apparente" and "solidité réelle". Ledoux, *L'architecture*, 45. Translation by the author.

21 "La saillie du toit que vous voyez et qui soustrait dans son développement l'apparente solidité que l'on désire, doit paroître hazardée". Ledoux, *L'Architecture*, 119. Translation by the author.

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